

# The Evolution of Outrigger Canoes from Fish Traps

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GLENN R. WHITLEY

## INTRODUCTION

THE OUTRIGGER CANOES of the southwest Pacific are well-known symbols of the Polynesians and other Far Eastern seafaring peoples. These boats were used to explore and colonize islands from Madagascar to Easter Island—places on the opposite sides of the earth, several thousand miles east and west of Australia. This study attempts to trace the outrigger canoe's development through its evolutionary history from the viewpoint of strict practicality in food gathering and transportation and argues that the seagoing outrigger canoe is the offspring of the early fusion of a basic transportation device (the dugout canoe) and a food-gathering mechanism (the fish ramp).

It is known that the island peoples of the South Pacific originally came from Southeast Asia in several waves and that, about the time of Christ, the first wave of colonists left Indonesia to settle the island of Madagascar (Murdock 1959:207); a second wave followed about the tenth century (Toussant 1966:53). This long and complicated process of migration is better explained elsewhere; this paper will concentrate on the outrigger canoe question.

The origin of the watercraft that allowed the colonization of a sizable portion of the globe must originally have been quite humble; the inventions that allowed the outrigger canoe to function so well may have been intended for other purposes at first. These original functions can still be seen today in some parts of Southeast Asia. The story can be compared to gunpowder, originally used for Chinese fireworks, even though its more serious use for firearms has dwarfed its original function. In the same way, the modern use of outrigger canoes overshadows the fishtraps that may have given birth to them. The chief advantage of this outrigger/fish ramp theory is that it allows a smooth and logical transition from the earliest times and most primitive model up until the latest and most complex. As has been pointed out by several avid sailors, a fisherman could have made a canoe trap simply by throwing his nets over the booms of his outrigger canoe. This theory assumes that this latter-day fisherman already had an outrigger canoe to begin with and begs the question of early outrigger canoe origins, which is addressed here.



Fig. 1 Canoe trap distribution.

### GEOGRAPHIC RANGE

The geographic range of the canoe-traps (as indicated by available resources, see Fig. 1) is centered between Bengal and Northeast China, with almost continuous distribution following the Southeast Asia coastline. Main offshoots expand into Java and the Philippine Islands and outliers are found as far east as the Solomon Islands and as far west as East Africa. The greatest number of variations, however, is found in China. The best, as well as the earliest, descriptions of canoe traps are derived from accounts of European travelers in China. Most writers credit China with the invention of the canoe trap, but the most primitive forms still extant are found in the Ganges delta area of India. Many prototypes and intermediate stages are still represented and preserved in the isolated marshes and calm, forgiving inlets and lagoons of the Ganges delta and the Southeast Asia littoral. It seems likely that such areas were more "forgiving" of mistakes and poor or amateurish workmanship than the more open and turbulent areas offshore. It is tempting to tie this canoe trap complex in with the Southeast Asia cultural hearth proposed by Sauer, Solheim, and others. I tend to agree with such a correlation.

### FISH TRAP DEVELOPMENT

I will leave the details of sailing and navigation to those who know them best and will deal with those aspects that relate to fishing and the trial-and-error type of engineering that lead to the less-sophisticated, nonsailing outrigger canoe. The most

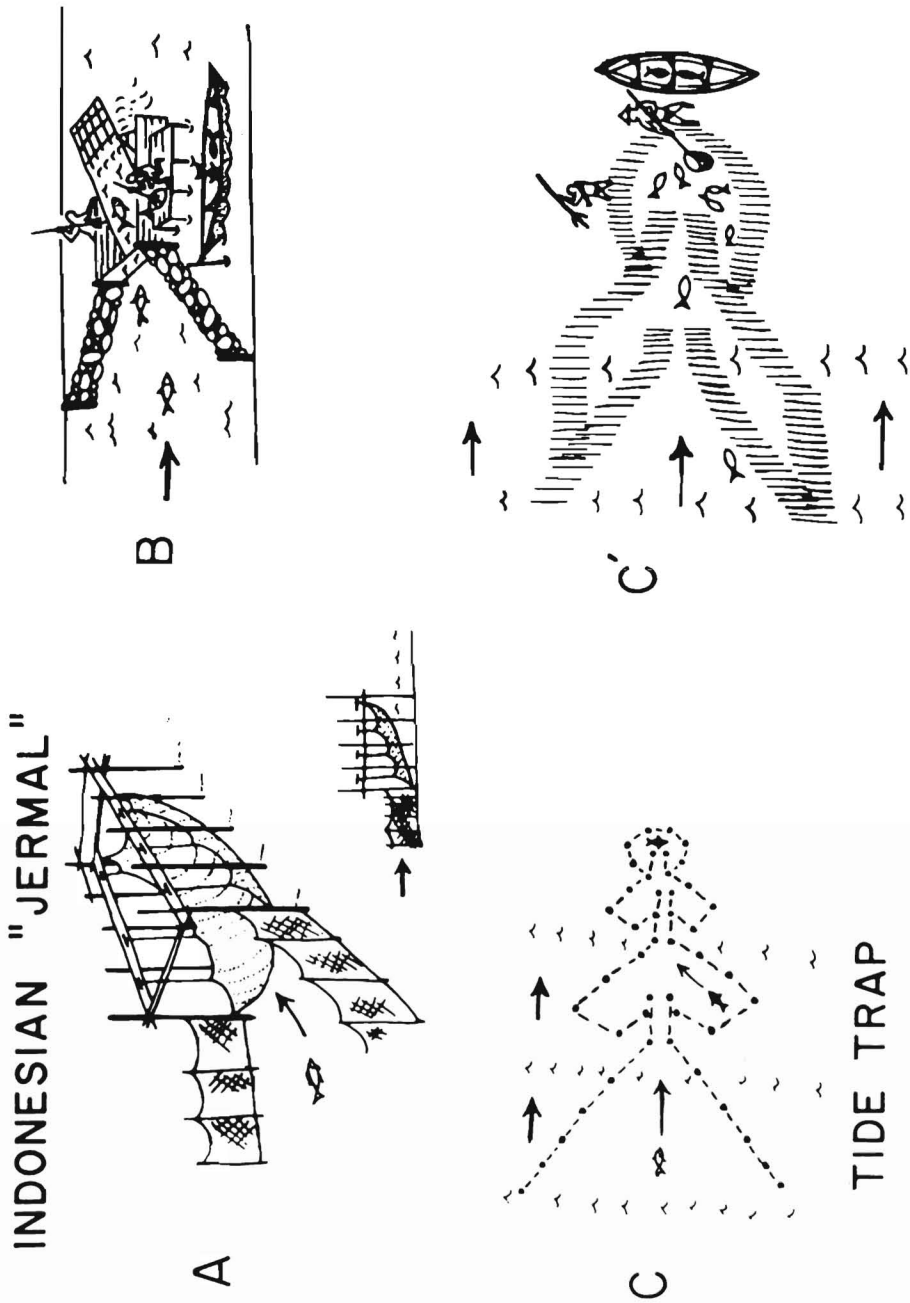


Fig. 2 Ramp and funnel traps.

primitive stage in this evolutionary sequence is the tide trap or fish ramp (see Fig. 2). The sequence of development was initially spurred by the observation that some edible and abundant fish jump clear of the water as a part of their escape behavior when startled (e.g., mullet), or when they encounter obstacles such as logjams or rapids when migrating upstream to spawn (e.g., salmon). In response to this early observation, the funnel-shaped fish weir or tide trap, which corrals and channels fish retreating seaward with the ebb tide into a series of ever smaller chambers, is found over most of the world among primitive coastal peoples, but especially in the southwest Pacific (Reinman 1967:125-128). Another example of this primitive method, which was probably widespread during the early Stone Age, is found among the Yugoslavs who still imitate natural logjams by bridging some brooks with a boat whose bottom contains rocks set to tilt it and catch fish that fall short as they attempt to leap the barrier/fish ramp (see Fig. 3-C). More usually, early Stone Age man improved on nature by building rock and timber walls to funnel both water and fish toward a ramp made of logs lashed together like a raft to form the common fish ramp. This "ramp and funnel" method can be oriented so that the funnel narrows and the ramp faces either upstream or downstream to catch fish moving in either direction. For fish, such as salmon, moving upstream against the current, a "spillway box trap" like those still used in northern Germany (see Fig. 3-B) can be used whereby a "live box" retains the prey after they leap the spillway created by a sluice box that concentrates the stream flow (von Brandt 1972:105).

For fish moving downstream, the early Germans also built a fish ramp that deflected jumping fish into a sloping trough, which empties the trapped fish into a container off to one side (see Figs. 3-A, 3-A'). Later mobile canoe traps imitated this action. For wider streams where a simple fish ramp is not practical, a funnel-like barrier concentrates the migrating fish up (von Brandt 1972:92) to the ramp or into a maze-like fish weir (Reinman 1967:126) where they can be speared or scooped up with nets (see Figs. 2-B and 2-C).

In a similar fashion, many areas in Southeast Asia have fish traps that operate to funnel in and trap fish retreating from the shoreline with the fall of water level during ebb tide. These widely distributed "tide traps" are typified by the Indonesian fixed *jermal* (see Fig. 2-A) and the smaller, transportable *si-stji*. The smaller, "semi-mobile" *si-stji* can be set up and taken down relatively quickly. The advantages of attaining full mobility and maximum flexibility will play a key role in the functional development of mobile canoe traps from fixed fish ramps (British Admiralty 1944:184-185). The problem with the stationary, permanent fish traps is that, over time, their very success often cuts down the locally breeding fish populations to unprofitable levels. The advantage of devising a fully mobile version of the "ramp-and-funnel" technique is obvious (see Fig. 4-B). In an effort to obtain this mobility (for example, in the Ganges delta), a lightweight bamboo raft is sometimes added to the ramp and funnel elements. Rafts are effective fish traps for some species (e.g., mullet, which commonly leap out of the water when frightened or confronted with an obstacle) and are commonly used in the Ganges delta area (Hornell 1926:216). In this case, lightweight bamboo rafts are used today by fishermen wading in the shallow waters of the Ganges delta. These men surround unwary schools of fish with long lines bearing floats at intervals, and, by skillful manipulation of these float lines, herd the fish toward the horizontal raft where they flounder about after they leap short (see Fig. 5). This raft is equipped with ramps and nets to make the fish jump and then hold them inside the raft (Hornell 1950:102-103). In a more elaborate,

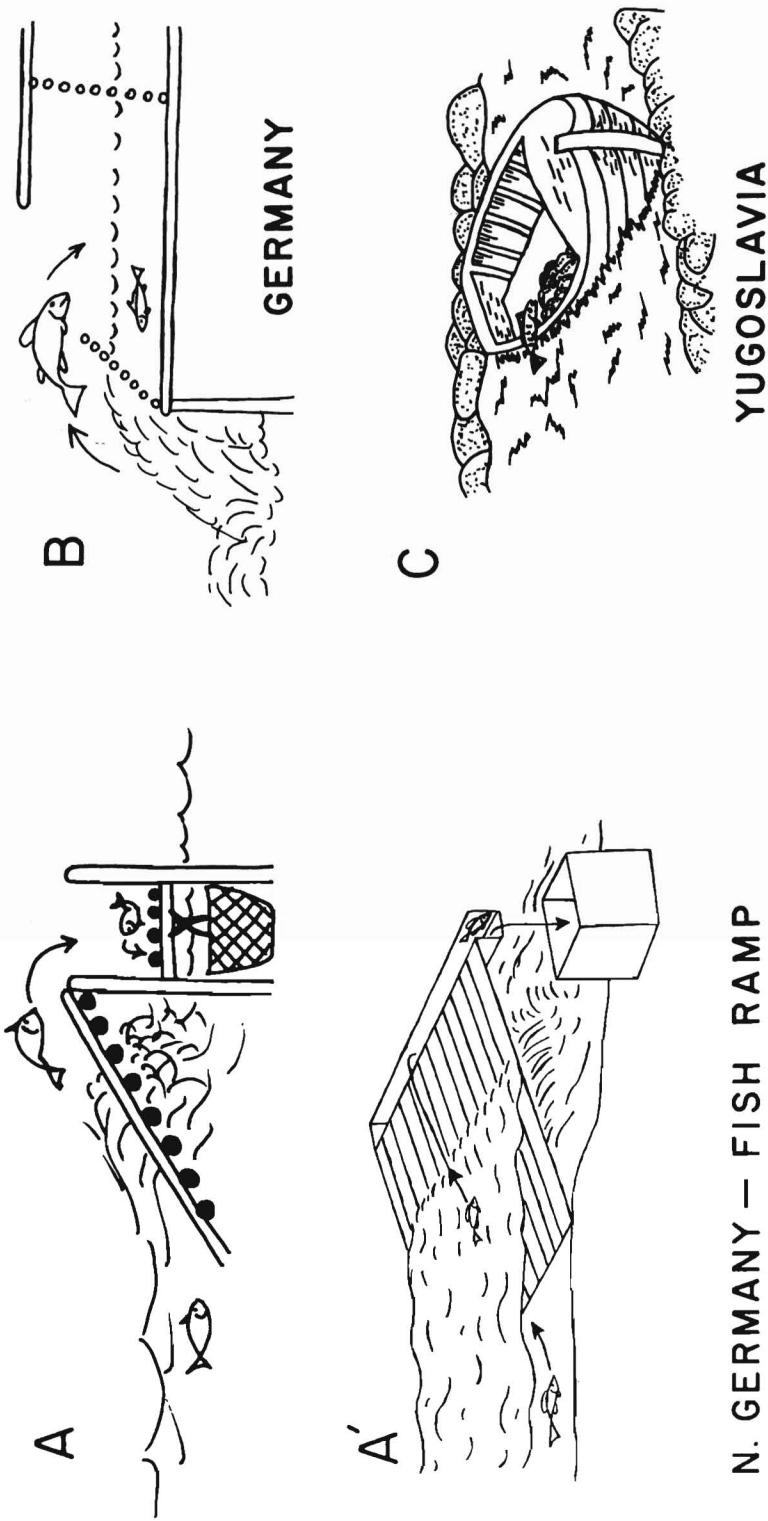


Fig. 3 Static fish ramp traps.

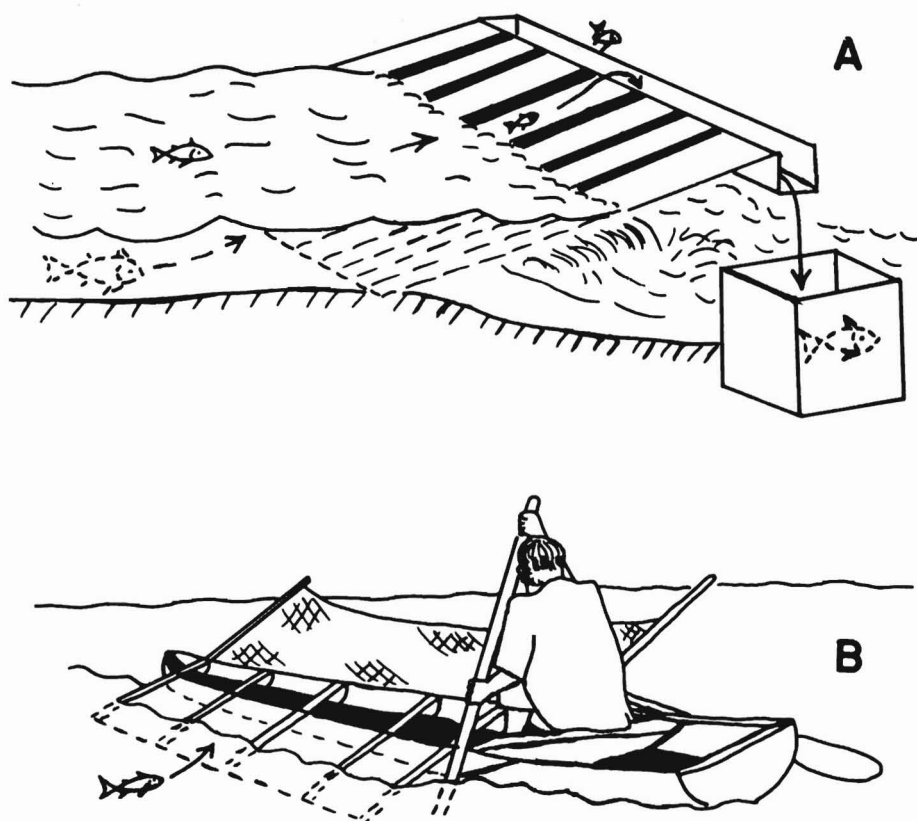


Fig. 4 Ramp traps.

multi-unit variation on the raft trap technique, the horizontal "veranda nets" of the eastern Mediterranean and Caspian seas are laid in a floating circle around a set of vertical gill nets that have already trapped a school of fish. The fishermen then enter the circle (see Figs. 6-A and 6-B) and splash vigorously to scare the fish into gilling themselves on the vertical hanging nets or into jumping onto the horizontal nets (von Brandt 1972:106, 109-110).

A further adaptation combines the fish corral or fish weir made of stakes with both horizontal and vertical nets with a funnel leading into one section. The Adriatic Sea variety of the "veranda net" attached to a framework of stakes (see Figs. 6-C and 6-C') is related to the Indonesian *jermal* and *si-stji* fish ramps (see Fig. 2-A) and to a similar Chinese method of "fishing in the air" with "winged" nets (see Fig. 7), which, unlike the *jermal* funnel trap, has the advantage of catching fish on either the incoming or the outgoing tide (von Brandt 1972:107-108). These barriers are "T"-shaped in cross-section (see Figs. 7-C and 7-D) and many later versions of Chinese mobile canoe traps utilize this idea of both a vertical and a horizontal net at the head of the fish ramp. A very functional canoe trap with tow ramps and a vertical net along the central axis of the boat is also used. This combined fish trap technique could have been synergized by some fisherman familiar with the fish ramp, the winged Chinese aerial nets, and dugout canoes.

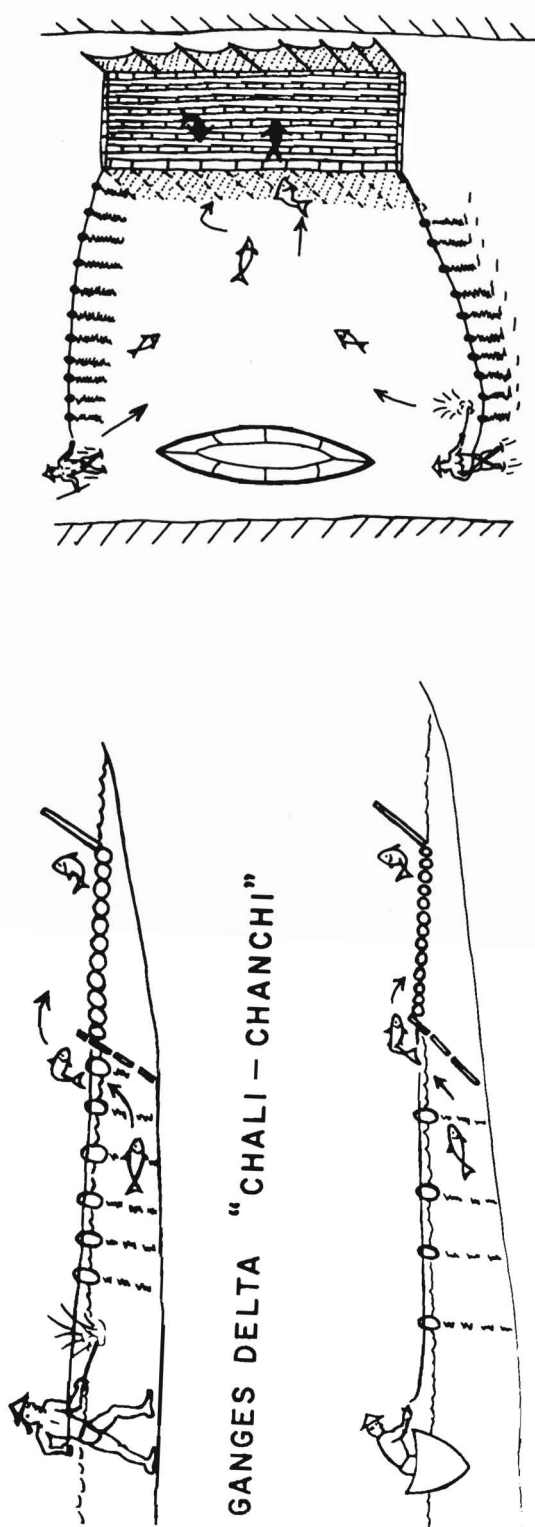


Fig. 5 Indian raft traps.

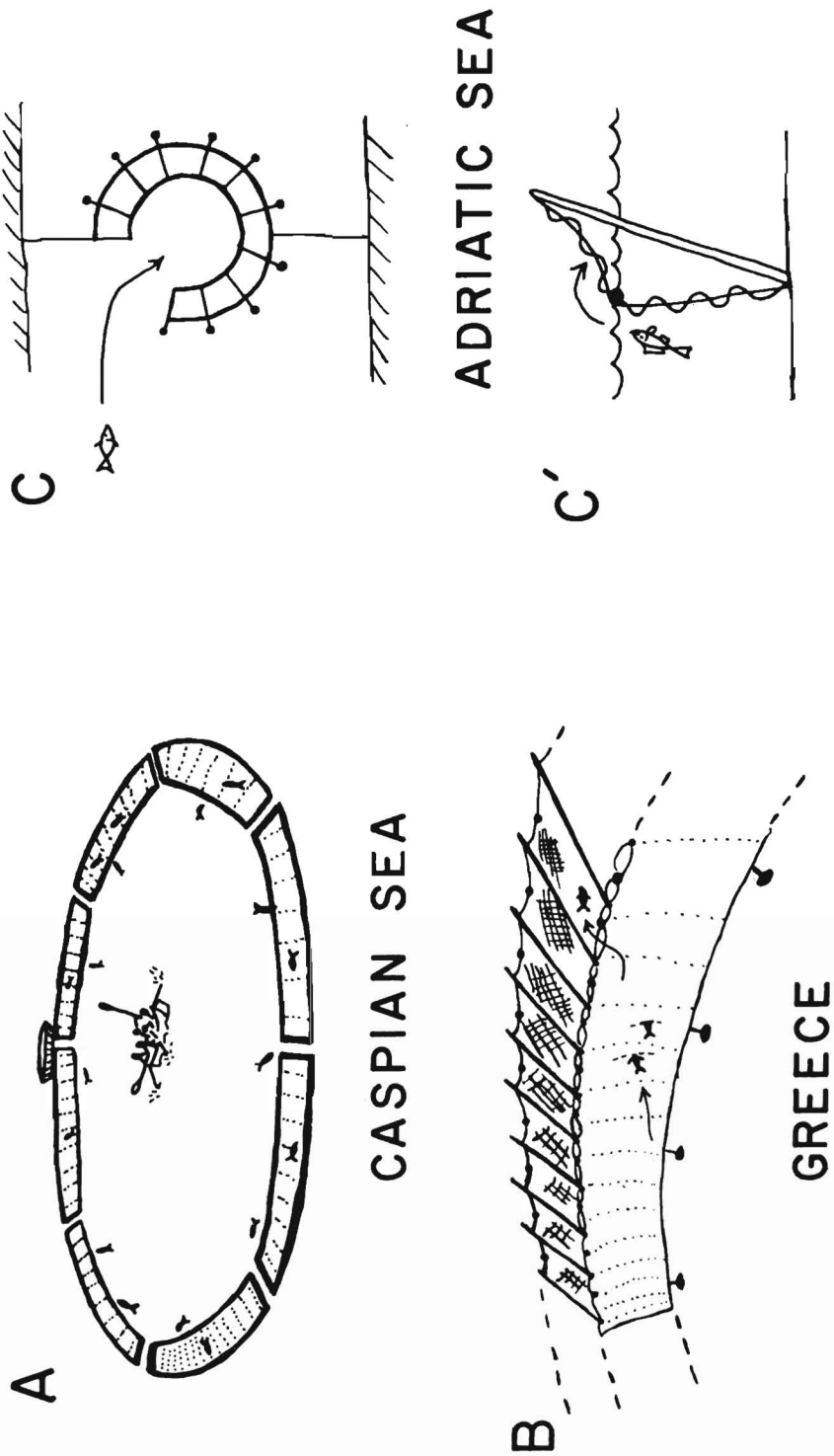


Fig. 6 Veranda nets.



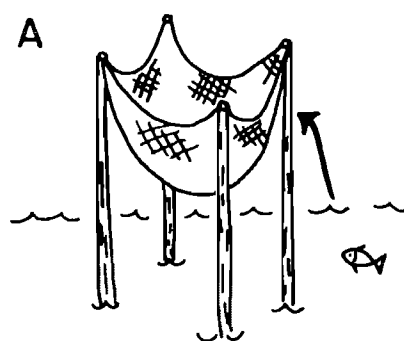
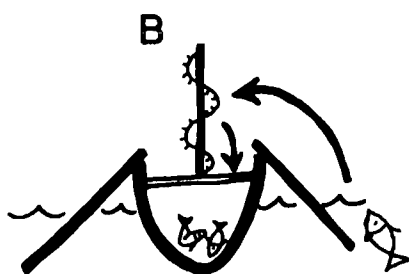
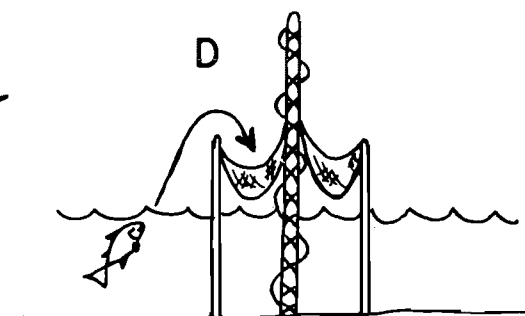
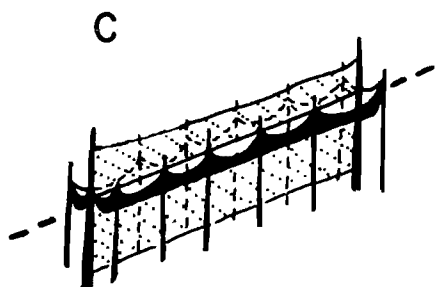
**BAG NET****CANOE TRAP****WINGED OR "T" NETS**

Fig. 7 Chinese aerial fish traps.

### CANOE TRAP DEVELOPMENT

The most primitive forms of the mobile fish ramps are still found in the lower Ganges River of Bangladesh where the Gangetic raft trap is used to catch the grey mullet (Hornell 1950:102). This fish is one of the most common and most highly esteemed in that area, but its herbaceous feeding habits and leaping escape behavior make it difficult to catch by hook or by ordinary nets, and it might be an under-utilized food resource without raft traps. The Bengalis have devised a variety of floating rafts, with some bright objects along the margins, to intentionally frighten the mullet into their instinctive reaction of jumping out of the water to confuse and shake off any pursuers, which causes some to land on the raft where they are stranded unless they manage to flop off the edge.

The most common variation is the *chali* or *chanchi* type (see Fig. 5) where a long, narrow raft made of reed matting is buoyed up by a row of white leaf-stems on each side. These stems keep the raft afloat as well as induce the mullet to jump and thus fall onto the raft, since white is the most visible color underwater as it reflects light.

This *chali/chanchi* raft trap has two main additions. In Murshidabad district the raft traps have bamboo reinforcing poles to stretch and strengthen them, plus a long, narrow net along the back to discourage escape. The other addition is used at Muzaffarpur; bundles of reeds and jute stems are tied to the margins of the raft to form a shallow tray so that fish cannot swim or splash their way back off the mat. Instead of being towed by the wading fishermen, these two more sophisticated models of the *chali* raft trap are used in conjunction with a boat (see Fig. 5) (Hornell 1950:102). From this model, it is a short evolutionary step to substitute a dugout canoe for the raft to arrive at a canoe trap.

Among the forms intermediate between the ramp/trap traps and canoe traps is the peculiar type called *chota sirki* at Muzaffarpur (see Fig. 12-C). One side of a dugout canoe is cut down almost to water level so that a screen of parallel jute stems can be hinged in this long gap to form a ramp into the hold of the boat. Although this *chota sirki* variation, or “cut-side canoe trap,” is unseaworthy and would ship water in waves of any size, it is very useful in quiet, shallow lagoons for harvesting smaller species, juvenile stages of larger fishes, and shrimp, none of which can jump very high. The great numbers of these species, which spend their early life cycles in the shallowest waters—where larger predators are at a disadvantage and detrital food is greatest—make this modification worthwhile. On moonlit nights, mullet swimming nearby become frightened when they come against the screens and try to leap, only to fall within the canoe. This canoe-and-ramp method is very commonly employed throughout the Mongolian countries (Hornell 1950:103), especially in Canton, Formosa, the Han River delta, and the Yangtze River delta regions (Audemard 1965:69–70). The Burmese, Vietnamese, and Thai all make extensive use of it, although regional models are varied in detail (see Fig. 8). In Bengal, the Bind people of the districts of Malda and Pabna specialize in the *chali* system of mullet fishing and have attained great dexterity in the manipulation of the different varieties of these devices. For example, Sir George Staunton (in 1797) describes boatmen in China who raise the ramp of the canoe trap (called *pa-pak-teng*) with strings to turn leaping fish into the boat before they flop off (Gudger 1937:296–297). This observation is supported by Pol Korrigan (writing in 1909) who states that this method of fishing with boats equipped with white-painted, hinged boards or ramps is practiced sparingly in various parts of China but most often in northeast China (the Grand Canal section above the Blue River). Gudger (1937:301) comments on this report that the ramp “is apparently hinged so that in case of rain it might be turned up and made to serve as a roof or cover to the boat.” Also, raising the ramp would have reduced drag through the water during travel. Sometimes two canoes are lashed parallel to each other and perpendicular to the current to form a “double canoe trap” and to catch larger fish able to jump clear over one canoe, especially in the zone from the Han River to Canton (Audemard 1965:70).

The advantage of the canoe trap is that it can be moved and is small enough to be operated by a two-man team rather than requiring large numbers of workers. In China there are a number of variations, often showing influence from the Chinese aerial or winged nets where vertical and horizontal nets are joined above the water-

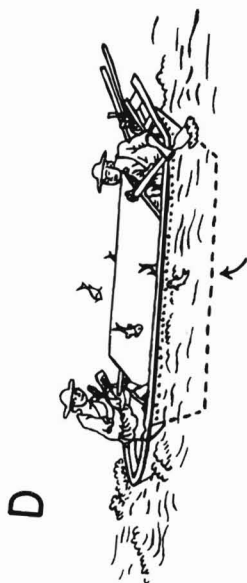
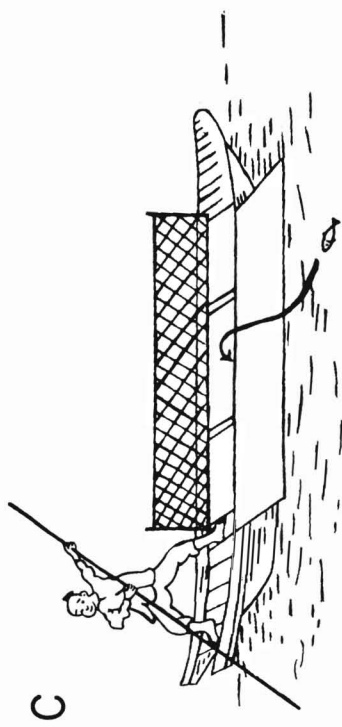
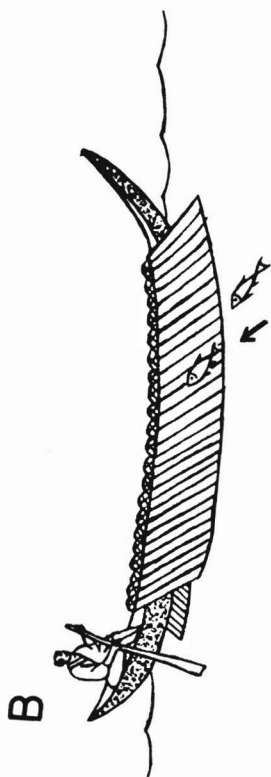
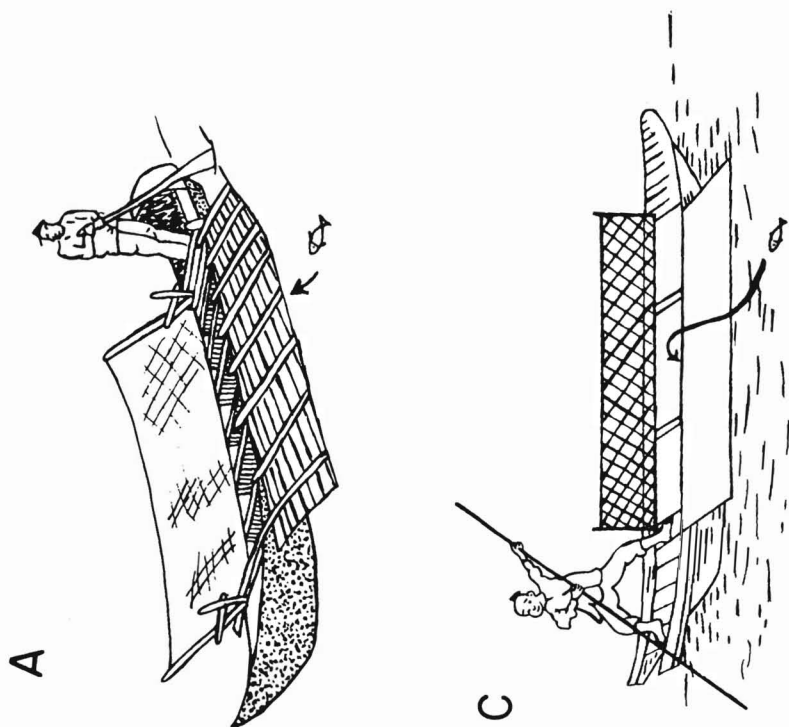


Fig. 8 Chinese canoe traps.

line in a cross or + shape so that fish leaping to avoid the lower barrier rebound off the upper vertical element and flop into the horizontal net, which sags to form a bag around them. On this Chinese canoe trap (see Fig. 8-C), the central vertical net deflects the fish trying to jump over the ramp, into the bottom of the boat (Paris 1955:59).

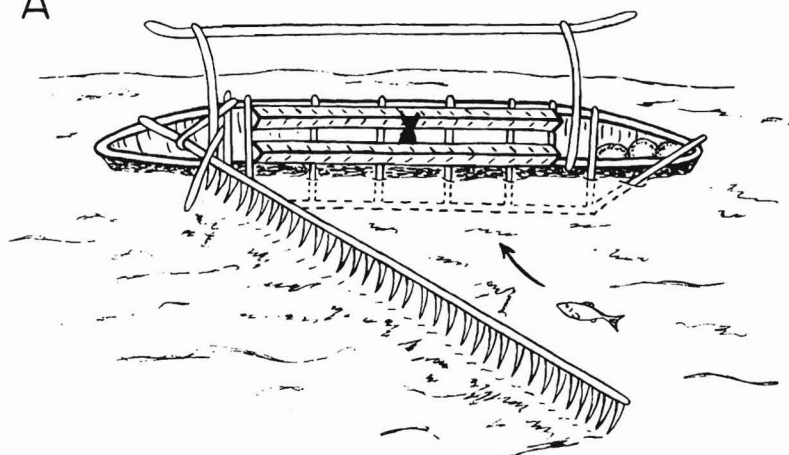
Fishermen using this technique row slowly—in daylight, by night in the moonlight, or by torchlight on moonless nights—in shallow water not far from the beach where they expect to find jumping fish. The beat the water with their oars or bang on the boat's side with a stick to make noise and cause vibration. The fish and shrimp, frightened by the commotion, flee from the beach area toward deeper water. Confronted by the white screen hanging over the side, they leap upward and into the boat. Sometimes a stone is suspended from the boat so that it drags on the shallow bottom or rushes through the water under the boat to further induce the mullet to jump rather than just glide away underneath the boat (von Brandt 1972:108).

The tilted canoe technique or broom-and-funnel method is a very popular device for fishing in shallow lagoons. Here a rock ballast in the bow tilts the canoe trap so that the depressed gunwale holding the ramp is only a few inches above the water. In this way the outrigger boom on the upraised side rides high in the air and sometimes carries a net stretched across it to catch the larger, more vigorous fish to deflect them back into the hold. As the extended boom with its attached brushes scrape the bottom of the lagoon the frightened fish are funneled toward the boat where the white ramp alongside the length of the canoe forces them to jump up so that they usually land in the hold of the canoe (see Fig. 9). In this awkward posture, the canoe trap is either poled or paddled along in quiet, shallow waters (often right at the shoreline). This method is often used at night or during twilight hours, as many fish come into the shallows to feed at that time. Torches and reflective white ramps are most effective in attracting and confusing the prey at night. This sophisticated method, typified by the *kalaskas* canoe trap of the Philippines (see Fig. 9-A), is also practiced in Thailand (von Brandt 1972:108–109), Annam, Bengal, and Burma, according to Francis Day in 1883 and Lindeman in 1880 (Gudger 1937:303–305). The word *kalaskas* is undoubtedly related to the Malayo-Polynesian words *kolekole* (outrigger canoe) and *kolek* (a small fishing boat) (Haddon 1920:117–118).

Another example of the rearrangements and recombinations of fishing and boating devices is found on the southern coast of India. Here the double canoe is combined with the canoe trap technique to form a peculiar craft that greatly resembles a single-canoe trap in operation. This method, called *changodam* or *changapayikkal* (see Fig. 10-B), would be especially efficient in narrow, dead-end channels where fish are bottled up between the banks and the double-canoe trap. According to Hornell (1950:106), this method of fishing is comparatively recent, dating, it is said locally, from about the beginning of this century. This method is a further sophistication of the double-canoe trap concept of the Han River and Canton, mentioned above.

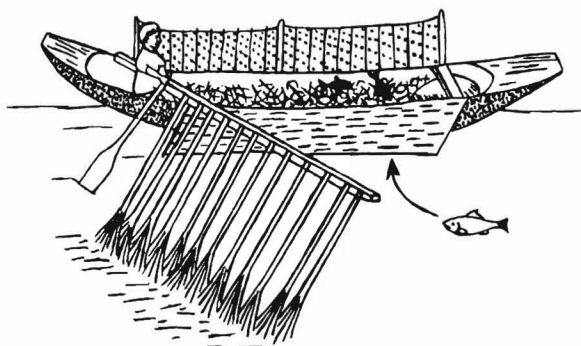
Hornell (1970:269–271) assumes that double outrigger canoes are more primitive and give rise to single outriggers by degeneration of one outrigger boom. He cites the Madagascar case where double outriggers (which were dominant until after 1600) seem to lose the float from one outrigger boom and reduce the size of this boom. As will be seen, this theory is probably incorrect due to Hornell's ignorance of the *vezo* communal method of employing canoe traps for offshore fishing. This

A



## PHILIPPINES "KALASKAS"

B

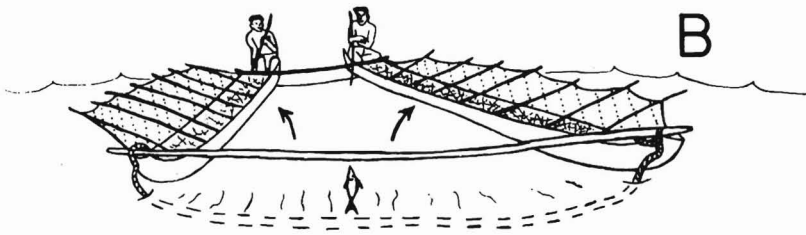


## ANNAM

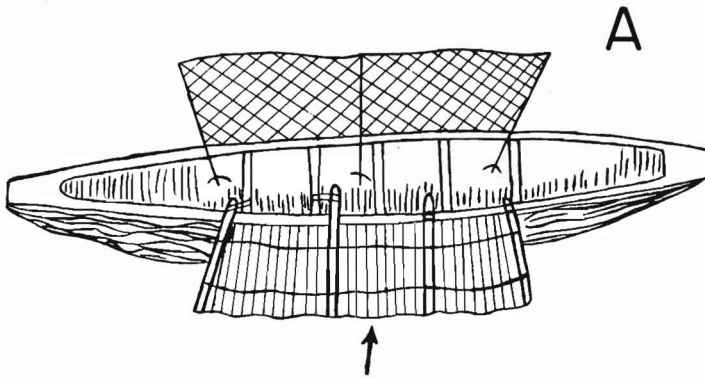
Fig. 9 Ramp and broom traps.

error points out the perils of trying to trace sailing vessel origins without considering the fishing methods that may have been associated with them.

This *vezo* method (Fig. 11), a combination of the canoe trap and the veranda net technique, is used in southern Madagascar where a whole village is involved and the fishermen operate offshore in deep water to catch surface-feeding schools of jack fish and large, mature mullet, which often jump clear of the water either in their feeding frenzy or to evade pursuit (Angot 1961: 158–159). Double outrigger canoes are used in which the second outrigger has only a frame with the float missing. Both out-



## S. INDIA "CHANGODAM"

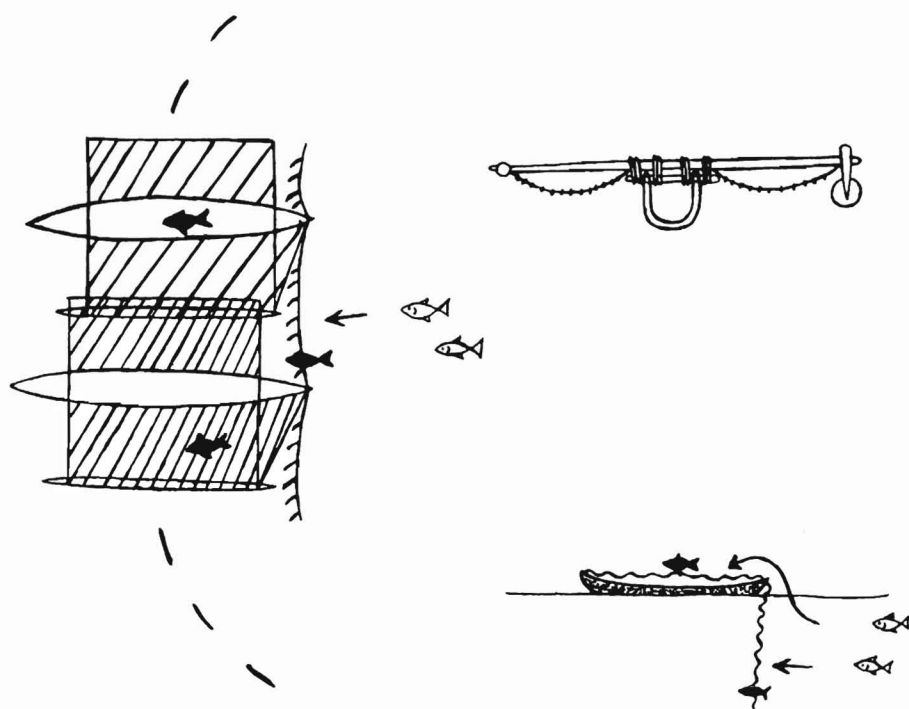


## INDIA, S.E. ASIA (SINGLE)

Fig. 10 Double canoe trap.

rigger booms of each boat in a semicircular line are covered with nets and overlapped with the outrigger booms of other canoes in a shingle-like arrangement to form a continuous net similar to a veranda net, with canoe hulls at regular intervals and a vertical gill net along the front of the whole line. Several chase boats herd a school of fish into the semicircle and close it to trap the school in a manner similar to the Mediterranean veranda net technique (see Fig. 6). This cooperative, deep-water method is much more efficient than the individual boats used in shallow-water, Southeast Asian environs as well as demonstrating a synergism of the Western veranda nets with the Eastern canoe traps.

A further advantage of this *vezo* method is that the outrigger nets duplicate the complete encirclement by floating Mediterranean veranda nets while retaining the mobility of single canoes, which can be quickly uncoupled and go their own way with their share of the catch. The boats can then scout for a new school of fish or can return home.



## S.E. MADAGASCAR—"VEZO"

Fig. 11 Oceanic canoe traps.

### OUTRIGGER CANOE EVOLUTION

The *vezo* method of Madagascar is of importance since Hornell (1970:269–270)—using Madagascar's peculiar double outrigger canoes as part of his reasoning—states that the double outrigger is the older form and degenerates into the single outrigger, although some authorities (Doran per. comm., 1977) disagree. However, since the loss of the second float is probably related to communal fishing methods such as the *vezo* technique, I suggest that this loss is a functional adaptation rather than a degeneration. The reason for considering the double outrigger canoe as newer and more sophisticated is that it is more stable than the single outrigger canoe under conditions of shifting, gusty winds such as near rain squalls. (I.e., as a double outrigger canoe starts to heel over in a sudden, dangerous gust, the lee side float will plunge under the water surface where its buoyancy will tend to retard further capsizing and will return the boat to an upright position. At the same time the increased drag of this submerged float also starts to turn the bow of the canoe away from the wind, thereby reducing the canoe-and-sail surface area exposed to the full force of the wind gust—a self-righting safety feature inherent in the design of the double

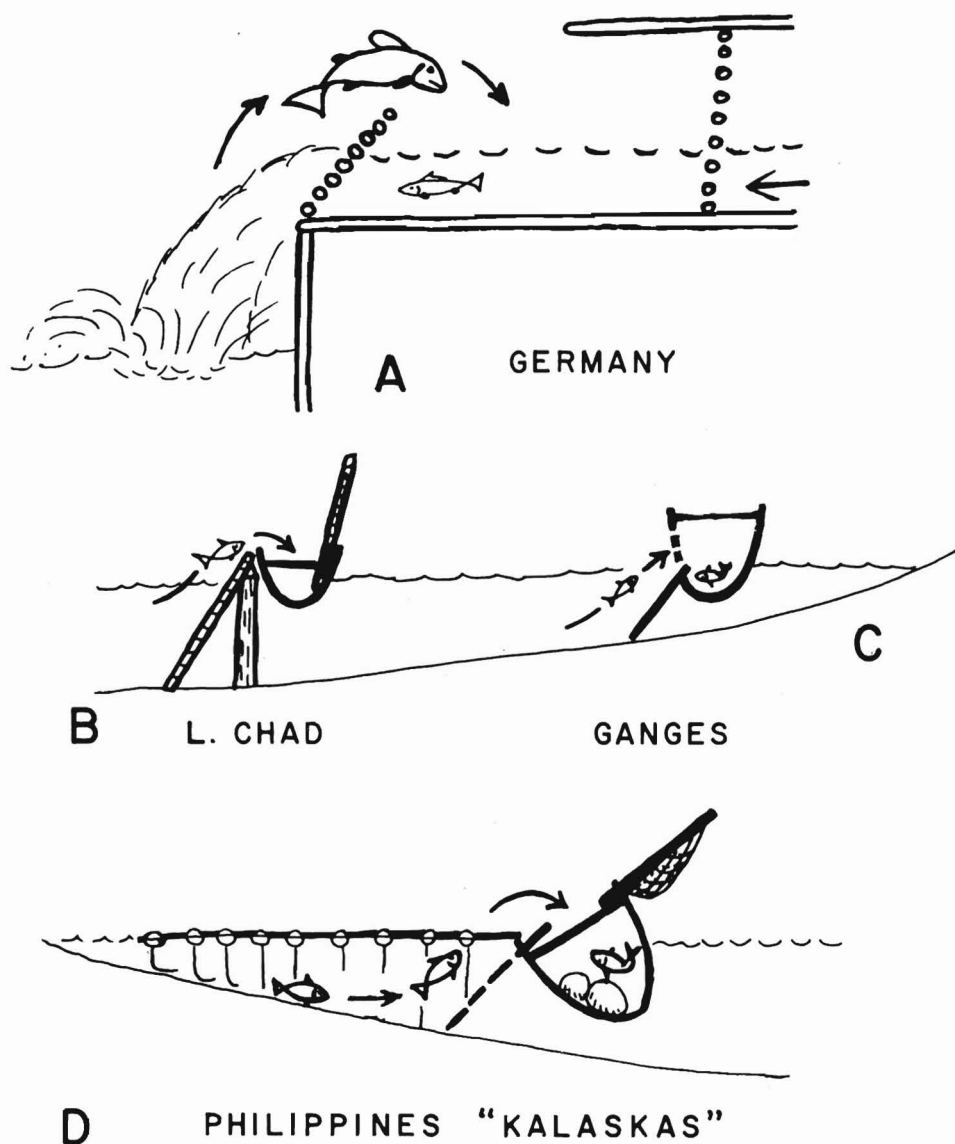


Fig. 12 Ramp trap evolution.

outrigger. In the meantime, the windward outrigger acts as a balance board upon which the alert boatmen can quickly throw their weight to help counteract the cap-sizing motion [Doran 1974:137].) I agree with the theory that the double outrigger canoe is a more recent and seaworthy adaptation than the single outrigger canoe.

Two hypotheses concerning the origin of outrigger canoes are listed by Haddon (1920:69-134). One hypothesis states that the single outrigger canoe is a degenerative form of the double canoe in which one canoe is replaced by a single outrigger's float. Haddon's other hypothesis is that the double outrigger canoes originate from



sailing rafts whose center log is larger than the others. The sailing raft also degenerates until only three logs are left and these become the dugout with two outriggers. On the other hand, Hornell (1970:265–266) believes that the double outrigger canoe developed from the Burmese rice boat of inland rivers. This rice boat is basically a dugout canoe with the sides built up with planks to increase its size and with two horizontal runways, which extended overboard on each side, for use in poling the boat through shallow waters. From these long runways, Hornell suggests, double outrigger booms developed for balance and floats were eventually added to give hydrodynamic lift on the lee side.

My own theory is that the single outrigger canoe trap originated from the Ganges raft trap, and later developed into the double outrigger canoe trap. The most sophisticated and efficient model of this single outrigger canoe is typified by the *kalaskas* type found in the Philippines. After the catch was secured, I think that the net and ramp booms were often left extended as counter-balances so that the fisherman's weight could be shifted quickly from one side to the other to offset any sudden wind gusts or current changes from either direction. This design offers an advantage over the single outrigger, whose float may be on the lee side and therefore not available for use as a balance board against which the fisherman can brace himself.

When a particular spot has been fished out, the outrigger ramps and nets can be unlashd and reshuffled to facilitate moving. Day-to-day experiments with the shipping and unshipping of these outboard mats, ramps, and brooms may have provided the process by which outrigger devices as instruments of balance and increased seaworthiness were developed. If wind and subsequent wave choppiness increased while fishing or while moving across deeper water to another likely fishing spot, the ramps and nets could be shifted so that both touched the water, acting as lateral or bilge cocks to retard further rolling. From these practical observations, I believe that the boatmen learned to put sections of hollow, buoyant bamboo on each boom to further help counteract rolling from one side to the other. Eventually the outrigger booms proved more versatile as aids to moving across rough waters than as mere supports for nets used to catch surface-feeding and shallow-water fish. Thus, a device like the ramp of the fixed fish ramp, which gave rise to the outboard ramps of the mobile fish trap or canoe trap—used only in shallow and protected waters—may have found a new functional adaptation as a floatation and stabilizing device for progressively more seaworthy and seagoing outrigger sailing canoes. These sailing outrigger canoes then ventured successfully into the expanses of open sea beyond the bays and between the islands of the Far Eastern archipelago until such migrations as the colonization of Borneo, and even Madagascar, were possible.

Haddon (1920:122,130) states that double outriggers are most stable (less likely to capsize), and are used more often for offshore work, especially commerce, which probably accounts for the large (30 ton) Javanese plank-built boats with double outriggers. Single outriggers seem to be most commonly used as small, inshore fishing boats, and the double outrigger for deep-sea work (Hornell 1920:111). I suspect that this is true because of the risk of capsizing in sudden wind and weather changes such as rain squalls. I suggest that the single outrigger canoe trap developed first in protected, nearshore waters with Chinese-type vertical nets to augment a single ramp off the left side of the canoe. This left-side ramp would not interfere with the rowing of right-handed boatmen in inshore waters as much as a right-handed ramp.

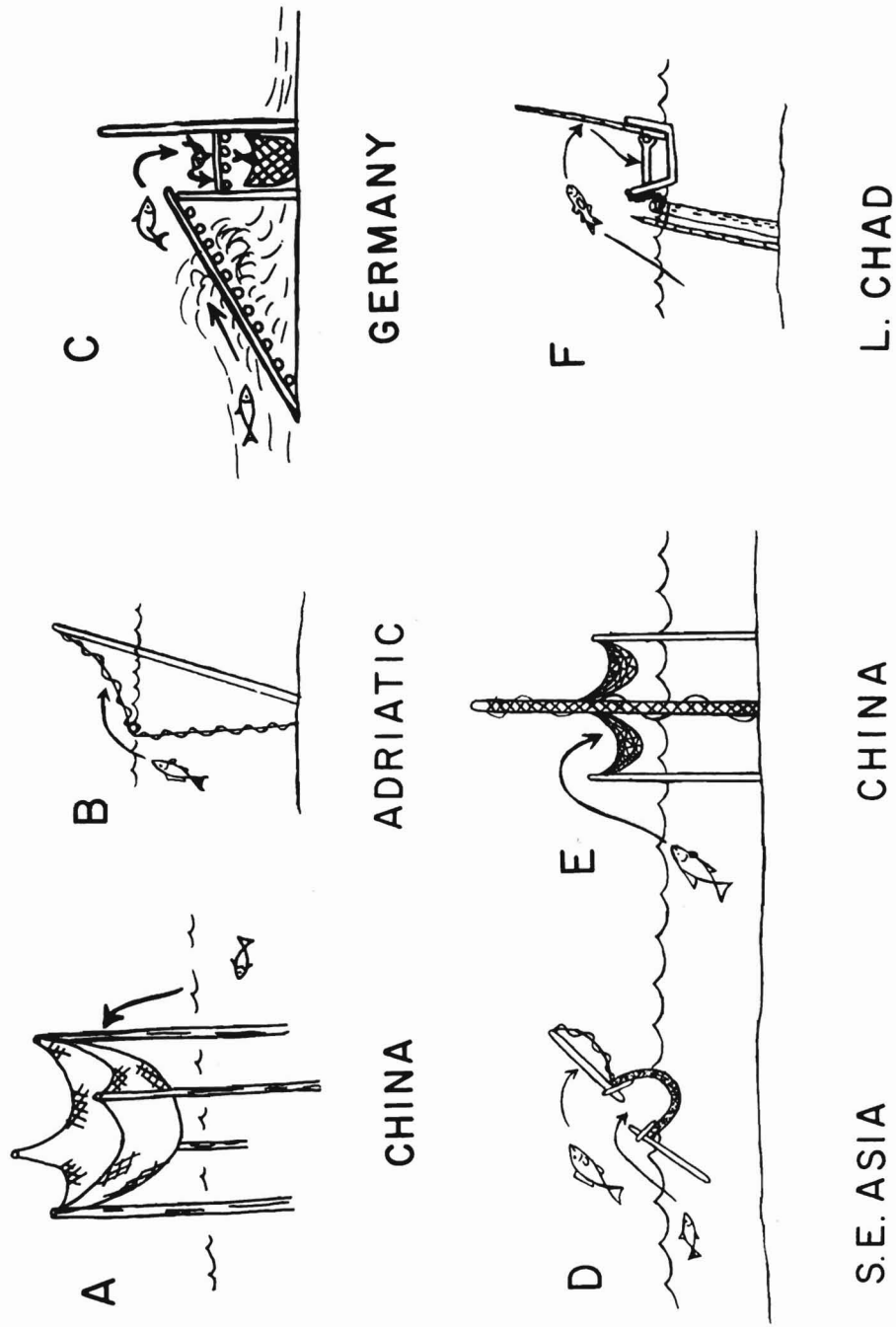


Fig. 13 Aerial trap evolution.

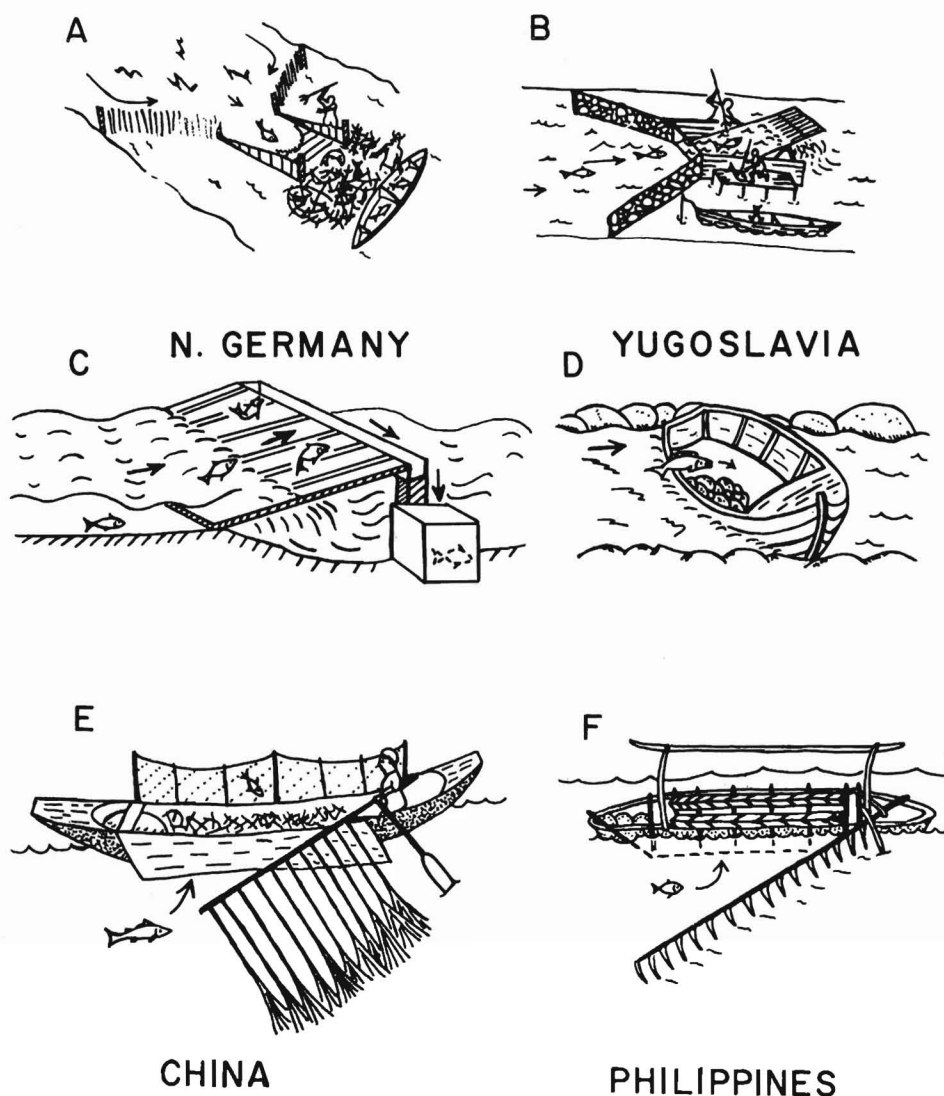


Fig. 14 Ramp and funnel traps.

## CONCLUSION

In brief, for the logical sequence of stages in the evolutionary development of the outrigger canoe from fish traps, I suggest the following models (see Figs. 13 and 14), which are parallel and probably merge to give the more sophisticated stages: (1) Ramp and funnel elements of the passive fish ramp plus dugout canoe give mobile canoe trap; (2) Aerial winged-nets or Chinese T-shaped nets plus dugout canoe give mobile canoe trap; (3) Canoe trap plus double canoe gives Changodam-type double canoe trap; (4) Canoe trap plus veranda net gives *vezo* communal canoe trap; (5) Canoe trap plus broom gives *kalaskas* canoe trap; and (6) Canoe trap plus floats give outrigger canoe.

Of course, I have greatly simplified a long and complex process and my theoretical reconstruction are prejudiced in favor of the references available to me. In spite of abbreviation and the perils of negative evidence, I contend that the fish ramp is the most primitive element and parent to the canoe trap, which in turn is parent to the sailing outrigger canoe. However, many readers may be more comfortable with the alternate theory that the canoe traps and sailing outrigger canoe are more like fraternal twins, i.e., born of the same parent ideas but developed side by side in the same environment, with the question of which was born first unanswerable, and perhaps unimportant, since both are mutually related to each other throughout their history.

Finally, I would like to suggest that this ancient fish-gathering method can be effectively adapted to new areas even today by the use of outboard motors and simple modifications to common modern smallcraft. These alterations would provide a means of increasing income from the collection and sale of bait and/or edible fish and shrimp in areas near urban markets located in low-lying coastal areas.

#### NOTE

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